

Methane Soil Flux Estimates Using Mobile and High Precision Cavity Ring-Down Spectroscopy



PICARRO

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Introduction

- Soil flux chamber measurements are critical for determining and for quantifying greenhouse gas (GHG) emission or sequestration.
- High-precision and high-accuracy GHG concentration measurements are required to determine soil flux.
- GasScouter offers the mobility for in-situ measurements and the high performance for accurate concentration measurements.
- Objective: To demonstrate the capability of the GasScouter combined with a soil chamber for soil flux measurements.

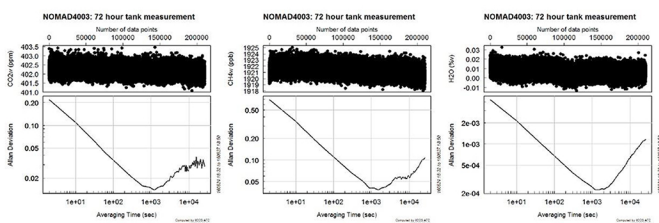
GasScouter, Model G4301:

- Simultaneously Measures CO₂, CH₄, and H₂O Concentrations at High Precision and Accuracy:

Table 1: Performance Specifications

	CO ₂	CH ₄	H ₂ O
Raw precision	0.4 ppm	3 ppb	100 ppm + 5%
Precision (5 min)	0.04 ppm	0.3 ppb	10 ppm + 5%
Drift (24 hr, 50 min avg.)	0.5 ppm	1 ppb	-
Measurement range	0 – 3 %	0 – 800 ppm	0-3% (non-condensing)

Figure 1: Allan Variance Plots from ICOS ATC Metrology Lab



- Proven Technology: Cavity Ring-Down Spectroscopy (CRDS).
- Compact, Mobile, and Lightweight: 25 lbs
- Low Power Consumption: 25 W
- Built-in Li-ion Battery for 8-hr autonomy.
- Hot-Swappable Battery for Uninterrupted Measurements
- WIFI Connectivity to Laptop, Tablet or Smartphone
- Built-in Vacuum Pump for Open or Closed-Loop Path

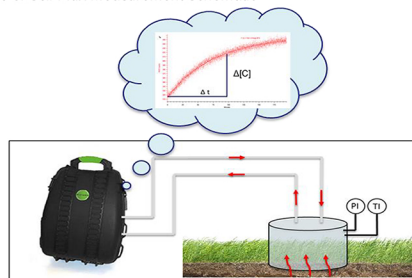


Figure 2: GasScouter

Method: Analyzer + Soil Chamber

- GasScouter analyzer directly connected to soil accumulation chamber in a closed-loop configuration.
- Continuous concentration measurements with high temporal resolution (up to 1 Hz) and high precision (ppb level).
- Gas flowrate of 1 L/min.
- Flux is defined as the rate of concentration change over a surface area.
- Flux measurement duration depends of the flux amount and the chamber size.

Figure 3: Soil Flux Measurement Schematic



Field Deployment

- Flux measurements of fugitive emission of CH₄ at a coal outcrop in the Four Corners Region, USA in the spring of 2016.
- 40-day campaign of on-foot flux survey.
- Metallic chamber of 3.5 L and an OD of 8 inch.
- Fluxes measured randomly at various locations at the coal outcrop site.

Figure 4: Coal Outcrop Site in Four Corners Region



Figure 5: Koveva Scientist



Results and Discussions

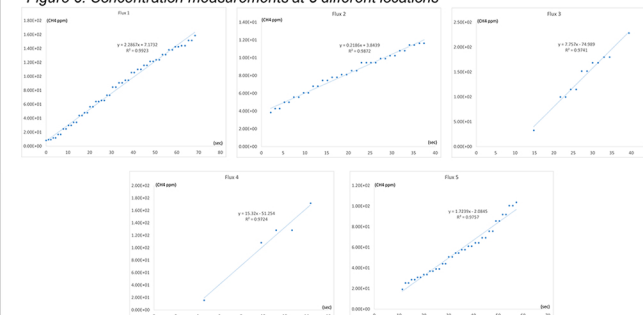
- Linear curve fit is the model used to estimate concentration rate of change.

- CH₄ flux calculation:

$$F = \Delta[\text{CH}_4] / \Delta t / V_m \times V/A$$

where F in mol/m²/s, [CH₄] in ppm, V_m in L/mol, V in m³, A in m²

Figure 6: Concentration measurements at 5 different locations



- CH₄ fluxes measured in Four Corners region range from 1 to 73 μmol/m²/s. In comparison, typical CH₄ flux is in the order of 0.1 μmol/m²/s.
- Flux measurements take between 10 to 70 seconds.
- Maximum CH₄ concentration measured is 230 ppm while typical methane concentration in the atmosphere is 2 ppm.

Table 2: Flux Result Summary

	Flux (μmol/m ² /s)	Max Meas. Concentration (ppm)	Measurement Time (sec)
Flux 1	10.88	160	70
Flux 2	1.05	12	40
Flux 3	33.88	230	25
Flux 4	72.82	170	10
Flux 5	8.18	110	50

Conclusions

- GasScouter offers a mobile solution for CH₄ soil flux measurements.
- Because of the high temporal resolution and the high precision of the concentration measurements, integration time for soil flux measurements is short, within 1 minute.
- Methane fluxes across four orders of magnitude can be measured.